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3,690,921

METHOD FOR STRONGLY ADHERING A METAL FILM ON CERAMIC SUBSTRATES

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No Drawing. Filed Dec. 7, 1970, Ser. No. 95,940

Int. Cl. C23c 3/02; C04b 41/38

U.S. Cl. 117—54

9 Claims

ABSTRACT OF THE DISCLOSURE

A method for metal plating ceramic substrates is provided. A ceramic substrate is prepared for metal plating by cleaning the substrate with a hot cleaning alkaline solution, rinsing with water, immersing the substrate in concentrated alkali metal hydroxide solution and heating to a temperature sufficient to remove water from the solution and thereby depositing the solid alkali metal hydroxide on the surface. Further heating the substrate to a temperature above the melting point of the deposited alkali metal hydroxide for a time sufficient to cause the molten alkali metal hydroxide to alter the surface by etching of both the Al_2O_3 and the binder in the substrate and thereafter cooling, rinsing and neutralizing the alkali metal hydroxide. Alternately, the cleaned dry substrate may be directly immersed in molten alkali metal hydroxide and rinsed in the same manner as before. The so-treated substrate may then be subjected to an electroless deposition bath for metal plating thereon. The resultant metal film is found to be strongly bonded to the ceramic substrate.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention is directed to a method for effecting a strong metal to ceramic bond. More specifically, the invention is directed to a method of treating a ceramic substrate with a molten alkali metal hydroxide prior to the deposition of a metal film thereon.

PRIOR ART

Ceramic materials are presently being considered for use in the printed circuit technology as substrates, upon which circuitry is disposed by plating techniques. In the preparation of the circuitry it is necessary to deposit a metal film generally, copper, in a predetermined pattern to describe a desired circuit. Ceramic materials are considered because of their insulative and heat conducting properties. The difficulty in using ceramic materials as substrates in plated metal printed circuitry is that up until presently, good metal to substrate bonding has been unattainable. It has been found that by use of the presently known technology of treating substrates, the plated copper peels away from the substrate due to the lack of good adherence or bonding thereto.

One technique of preparing a conductive pattern on a ceramic substrate is by screening a conductive paste in a predetermined pattern onto a ceramic substrate and firing the coated ceramic substrate to effect a bond of the conductive paste to the ceramic substrate. While this method has met with some success, it has been found to be rather expensive. A more economical method would be the use of conventional plating technology. The plating technology requires far less expensive materials and gives greater circuit density than can be obtained by the screening technique.

It is generally known in the art to treat a substrate in a strong alkaline solution prior to plating the same. For example, in U.S. Patent No. 2,764,502 there is disclosed

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a method of treating resinous materials to improve their adhesion characteristics by surface treating the plastic with a strong hot alkaline solution for a few minutes and then rinsing off excess solution and drying. An electroless copper plate may then be applied to the substrate. In U.S. Patent No. 3,202,589 there is disclosed a method of electroplating zinc base die castings by anodically treating the castings in a strong alkaline electrolyte for surface modification, after which the electroplating operation is performed. In U.S. Patent No. 2,955,954, a process for treating shaped articles prepared from synthetic polymers is provided and in which the article is treated with a caustic solution of sufficient strength to activate the surface of the article. Sodium bicarbonate is the preferred caustic. U.S. Patent No. 3,296,012 discloses a method of electrolessly depositing copper onto the surface of a ceramic substrate. The method includes leaching the substrate with a strong acid and further treatment in hydrogen peroxide.

There is no disclosure of utilizing a molten alkali metal hydroxide to modify the surface of a ceramic substrate in any of the above-mentioned prior art.

SUMMARY OF THE INVENTION

There is provided a method for electrolessly and/or electrolytically metal plating a ceramic surface which includes the treating of the surface with molten alkali metal hydroxide prior to metal deposition. The method is characterized by the altering of the ceramic surface by the molten alkali metal hydroxide. Stepwise, the method is comprised of cleaning a ceramic substrate in a hot K-2 solution (an alkaline cleaning solution prepared by The Pennsalt Co.) to remove grease, powder and the like from the surface of the ceramic substrate, immersing the substrate in concentrated alkaline solution, e.g., 50 grams of sodium hydroxide dissolved in 100 ml. of water, removing the substrate from the alkaline solution and heating at a temperature of about 170° C. to remove water and thereby deposit a film of the alkali metal hydroxide on the surface of the substrate, heating the substrate at a temperature sufficient to fuse the alkali metal hydroxide film on the surface of the ceramic surface and for a time sufficient for the fused alkali to alter the surface of the substrate. Alternately, the clean, dry substrate may be directly immersed in a container of alkali metal hydroxide heated at a temperature above the melting point of the alkali metal hydroxide. The substrate is cooled and rinsed in water and thereafter re-rinsed in a dilute acid solution to neutralize the alkali. The substrate is finally rinsed in water to remove the acid and fines of Al_2O_3 and thereafter dried. The substrate can then be immersed in a conventional electroless plating bath to deposit a strongly adhering metal onto the surface and without further treatment of the surface. Metal to substrate bonds are obtained by this treatment having values of 6 to 8 lbs. per inch according to the 90° peel test. In pull tests strength on 150 mil copper dots on the treated surface provided bond strengths sufficient to break the wafer without removing the metal adhering thereto. For example, as much as 85 lbs. of pull was exerted without removing the coated copper film.

OBJECTS OF THE INVENTION

It is an object of the invention to provide a method for strongly adhering a metal to a ceramic surface.

It is another object of the invention to provide a novel method of treating the surface of a ceramic material prior to metal deposition thereon.

It is a further object of the invention to provide a method which is featured by the step of treating the surface with a molten alkali metal hydroxide.